FEA Important Questions

Two Marks

1. Demonstrate discretization in finite element method with suitable sketch.
2. State the methods of engineering analysis?
3. List out the various types of finite elements used to model in FEA.
4. Show the various methods available to satisfy the weighted residual formulation.
5. Define Truss element.
6. Why polynomial are generally used as shape function? Explain.
7. Explain plain stress and strain condition
8. State the properties of a stiffness matrix.
9. Mention the finite element equation for one dimensional heat conduction.
10. Enumerate the CST and LST triangular elements.
11. Differentiate between subparametric, isoparametric and superparametric elements
12. Write the strain-displacement matrix for CST element.
13. Mention the finite element equation for one dimensional heat conduction with free end convection.
14. What is steady state heat transfer and write its governing equations.
15. Write down the Gaussian quadrature expression for numerical integration
16. Write down the Fourier's law for one dimensional heat flow and List out three main mechanisms of heat transfer.
17. With example, define serendipity elements.
18. Write down the shape functions for 4-noded linear quadrilateral element using natural coordinate system.

19. Write the conduction, convection, and thermal load matrices for one dimensional heat transfer through a fin.

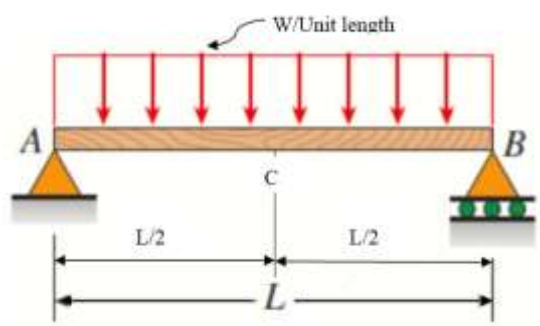
20. List down the advantages of Gaussian quadrature numerical integration for isoperimetric elements.

21. A 20-cm thick wall of an industrial furnace is constructed using fireclay bricks that have a thermal conductivity of k = 2 W/m-°C. During steady state operation, the furnace wall has a temperature of 800°C on the inside and 300°C on the outside. If one of the walls of the furnace has a surface area of 2 m^2 (with 20-cm thickness), find the rate of heat transfer and rate of heat loss through the wall.

22. What is steady state heat transfer and write its governing equations.

14 Marks

1. Use Rayleigh Ritz method determine the deflection at the center of the a simply supported beam of span length "L" subjected to uniformly distributed load through its length as shown in figure



2. Discuss the general procedure of finite element analysis with help of suitable sketch.
3. Explain the types of engineering applications with suitable applications.
4. The following differential equation is available for a physical phenomenon. $\frac{d^2y}{dx^2}+50=0, 0\le x\le 10$, Trail function is, $y=a_1x(10x-x)$, Boundary conditions are, y(0)=0, y(10)=0. Find the value of the parameter a_1 by the following methods: (i) Point collocation method; (ii) Subdomain collocation method; (iii) Least squares method; (iv) Galerkin's method.

5. The differential equation of physical phenomenon is given by Trial function,

$$\frac{d^2y}{dx^2}+500x^2=0,\ 0\le x\le 1, Trial\ function, y=a_1(x-x^4),$$

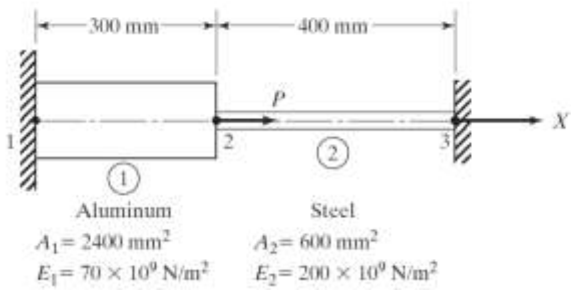
Boundary condition are, y(0)=0, y(1)=0 calculate the value of the parameter $a_1$by the following methods. (i) Point collocation method (ii) Sub-domain collocation method (iii) least Square Method and (iv) Galerkin's method.

6. Derive the shape function and stiffness matrix for one dimensional bar element using global coordinate system.
7. Consider the bar shown in Fig. An axial load P = 200 x 103 N is applied as shown in figure 2. Using the penalty approach for handling boundary conditions, do the following:

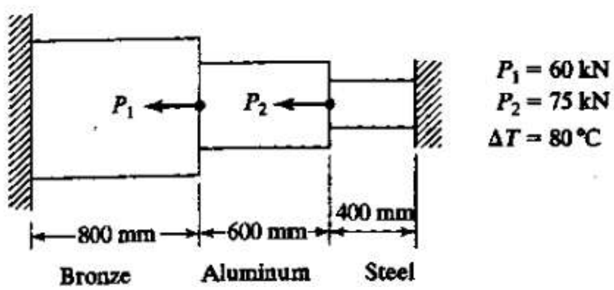
(i) Determine the nodal displacements.

(ii) Determine the stress in each material.

(iii) Determine the reaction forces.

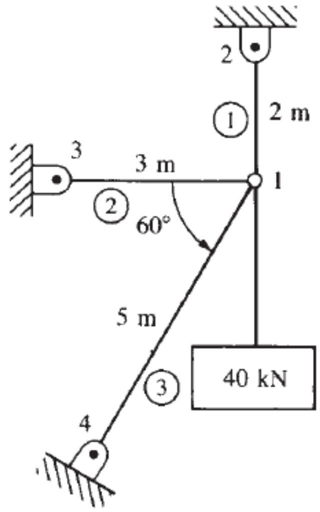


8. The structure shown in figure 1, is subjected to an increase in temperature of $80°C$. Determine the displacements, stress and support reactions. Assume the following data:



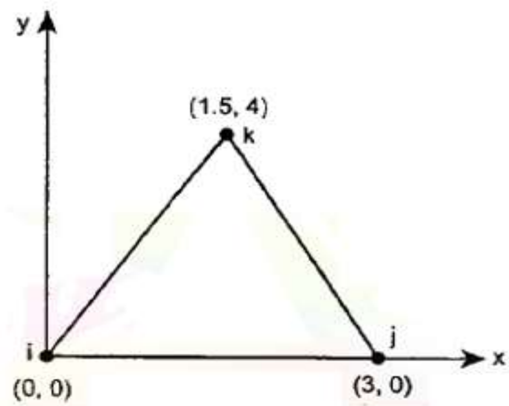
Bronze	Aluminium	steel
A=2400mm^2	1200mm^2	600mm^2
E=83GPa	E=70GPa	E=200GPa
$\alpha = 18.9\times10^{-6}$ / °C	$\alpha = 23\times10^{-6}$ / °C	$\alpha = 11.7\times10^{-6}$ / °C

9. For the plane truss shown in Figure, determine the horizontal and vertical displacements at node 1 and the stresses in each element. All elements have E =210 GPa and $A = 4 \times 10^{-4} m^2$

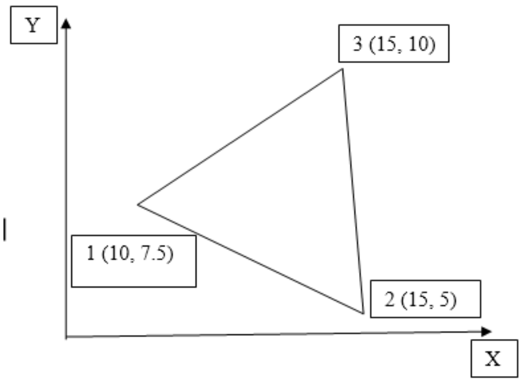


10. Evaluate the element stiffness matrix for the triangular element shown in figure. Under plane stress conditions. Assume the following values:

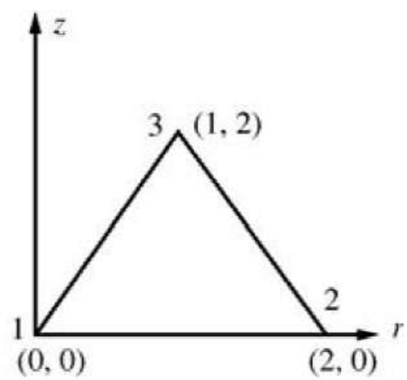
E=2 x 10^5 N/mm^2; $\mu = 0.3$; t=10mm.



11. Determine the element stresses $\sigma_x, \sigma_y, \tau_{xy}, \sigma_1,$ and σ_2 and the principal angle θ_p. The coordinates are given in units of millimetres as shown in figure 4. Assume plane stress conditions. Let $E = 210GPa$, $v = 0.25mm$. For the elements given in Figure, the nodal displacements are given as $u_1 = 2.0mm$, $v_1 = 1.0mm$, $u_2 = 0.5mm$, $v_2 = 0.0mm$, $u_3 = 3.0mm$, $v_3 = 1.0mm$.

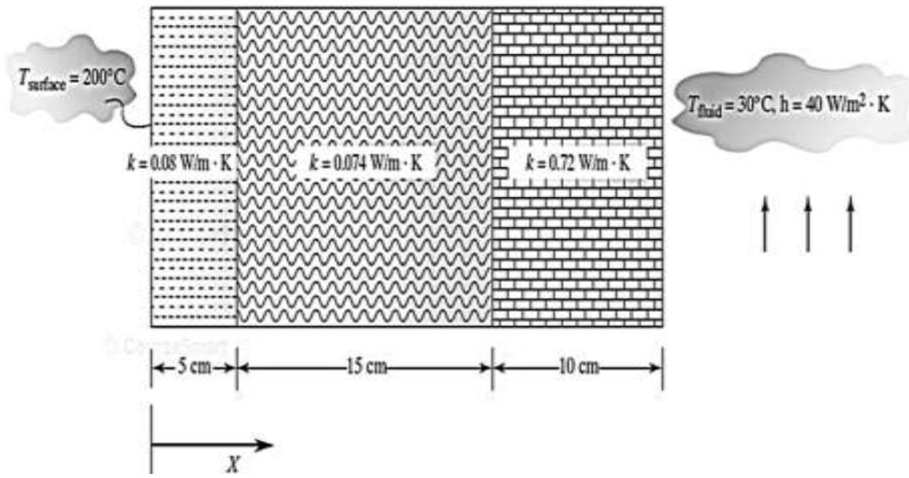


12. For the axisymmetric elements shown in Figure, evaluate the stiffness matrix. The coordinates (in millimetres) are shown in the figures. Let E = 210 GPa and μ =0:25 for each element.

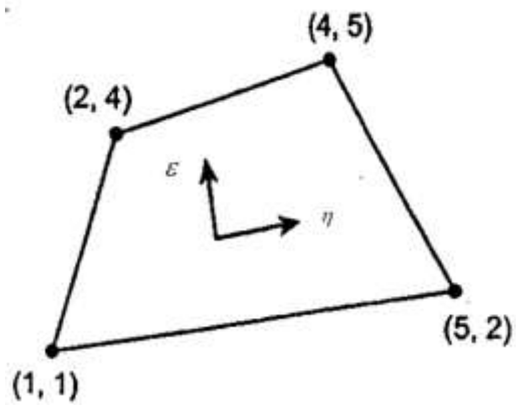


13. Derive the stiffness matrix for one dimension heat conduction, with perimeter convection and with free end convection.

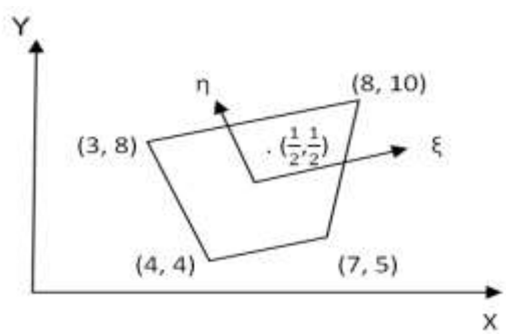
14. A wall of an industrial oven consists of three different materials, as depicted in figure. The first layer is composed of 5cm of insulating cement with a clay binder that has a thermal conductivity of 0.08W/m.K. The second layer is made from 15cm of 6-ply asbestos board with a thermal conductivity of 0.074W/m.K. The exterior consists of 10cm common brick with a thermal conductivity of 0.72W/m2.K. The inside wall temperature of oven is 200 $^{\circ}C$, and the outside air is 30 $^{\circ}C$ with a convection coefficient of $40W / m^2.K$. Determine the temperature distribution along the composite wall.



15. Establish the strain-displacement matrix for the linear quadrilateral element as shown in figure .0. at Gauss point $\varepsilon = 0.57735$ *and* $\eta = -0.57735$.



16. Evaluate [J] at ξ=η=1/2 for the linear quadrilateral element shown in figure



17. Evaluate the integral $\int_{-1}^{-1} (x^4 - 3x + 7)\, dx$ using Gauss integration.

18. Evaluate the integral $I = \int_{-1}^{+1} \frac{\cos x}{1 - x^2}\, dx$ by applying three point Gaussian quadrature.

19. Evaluate the integral $I = \int_{-1}^{1} \cos \frac{\Pi x}{2} dx$ using one point, two-point, three point and four point Gauss quadrature compare with exact solution.

20. Evaluate $\int_{-1}^{1} (x^4 + 3x^3 - x) dx$ by applying 3 point Gaussian quadrature and compare with exact solution.